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Assessment of Physiology and Quality Performances of Cut Foliage Plant (*Asparagus plumosus*) under Coloured Shade Nets

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Abstract

The investigations were carried out during 2016–17 and 2017–18 under three different coloured shade nets (white, green and red) along with the controlled environment (open condition) at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India to study the production behavior of *Asparagus plumosus*, India. The experiments were arranged in Complete Randomized Design (CRD) with four replications and maintained in pots. Similar management practices were followed for all the treatments throughout the growing period. The pooled data of two years revealed that plants grown under the green shade net showed significant improvement in all the vegetative parameters i.e. plant height (109.6 cm), plant spread (70.67 cm), leaf length (33.35 cm), leaf breadth (22.00 cm) and petiole girth (0.80 cm), whereas lowest data observed in the plants maintained without any shade net. The leaf production was also better in the plants raised under green shade net than other treatments. The highest number of leaves per plant and leaf longevity was found in green shade net treatment. The leaf production interval was remarkably lowest in the plants grown under green shade net. The leaf quality was better under green shade net in terms of colour intensity, vase life and chlorophyll content. The green shade net gave overall better performance regarding both physiological and quality parameters and can be suitable for commercial cultivation.

Keywords: *Asparagus plumosus,* shade net, transmittance, quality

1. Introduction

Cut foliage is an essential element of the floricultural industry and largely used as ornamental filler in bouquet, background and lining material to provide contrast and bring a sense of liveliness in the flower arrangement (Reid and Jiang, 2012). Cut foliages have a great opportunity in the local as well as foreign markets and can play a valuable role in the economic upliftment of the farmers (El-Ghait et al., 2012). The use of these bio-degradable decorative foliages as fillers in bouquet making has increased substantially from 5% to 20–25% (Bhattacharjee, 2006). In India, commercial production of cut foliages has flourished in recent years because of its huge demand, especially during festivals and annual events.

Among the different cut foliages, ferns are highly demanding in international floral markets for its year-round availability, long shelf life and also various design attributes regarding colour, form and texture

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(Safeena et al., 2019). There are many asparagus species viz. *A. densiflorus*, *A. myriocladus*, *A. plumosus, A. virgatus* etc. becoming popular for the use in various flower arrangements (Stamps, 2009). *Asparagus plumosus* is one of the common cut foliages seen everywhere in floral decorations. It is a scrambling herbaceous perennial with tough green stems and flat, plume-like foliages (Anonymous, 2016a).

Artificial shading is used to grow two-third of the world's fern production because most of the ferns need shady conditions to produce better quality foliage (Strandberg, 2003). The enhancement of plant quality and production is possible by manipulating different environmental factors (Pollastrini et al., 2011 and Darko et al., 2014). Shade nets are mainly used to grow plants under environmental modification (light, temperature, humidity) (Khyber et al. 2019), where the spectrum of the incoming solar radiation is transformed into diffused light (Shahak, 2014), and also wind speed and wind run is reduced (Gaurav et al., 2015) which affects temperature, humidity and gaseous exchanges (Kittas et al., 2012). Due to these modifications, shade nets are able to amplify the water use efficiency, decrease the consumption of water as well as enhance the productivity of the crop (Ahemd et al., 2016). There are various colours of shade nets viz. red, white, green, blue, yellow, gray and pearl available in the markets (Al-Helal and Abdel-Ghany, 2010). These coloured shade nets modify light quantity and quality underneath and have different impacts on the plant growth and quality performances (Mupambi et al., 2018 and Ilic et al., 2017). Beside this the scattered light of coloured shade nets enters deeply and uniformly into the dense foliages which is a specialty of coloured shade net technology (Ilic et al., 2015 and Kong et al., 2013). The year-round production of cut foliages with minimum investment and less maintenance has an advantage over the season specific cut flowers. Therefore, the present research was carried out with the aim to find out the suitable shade environment for better growth and quality production of *Asparagus plumosus* which can influence the farmers to cultivate Asparagus commercially and help them to gain more profit.

2. Materials and Methods

2.1. Description of the study site

The present experiment was conducted under All India Coordinated Research Project on Floriculture at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India during March–February of 2016–17 and 2017–18. The experimental site is located at $23^{0}05$" Northern latitude and 89° Eastern longitudes and at an elevation of 9.75 m above the mean sea level with an average temperature range from 21°C to 30°C and 81% relative humidity. The annual average rainfall of this location is 950 mm to 1200 mm.

2.2. Experimental design and procedure

The research work was laid out in Complete Randomized Design (CRD) with four replications, where plants were raised and evaluated under three different shade nets i.e. White (50%), Green (50%) and Red (50%) as well as without shade net. Healthy and uniform plants were planted in the month of March in 20× 20 cm^2 pots where sandy loam soil and cow dung manure in 3:1 proportion was used as growing media. The management practices were similar for all the treatments. Plants were fertilized with 19:19:19 (1 g l^{-1} of water at monthly interval) throughout the growing period.

2.3. Method of data collection

There were 10 pots in each replication and among them 3 plants were selected randomly for recording the observations. The pooled data on physiological parameters (plant height, plant spread, leaf length, leaf breadth, number of leaves $plant^{-1}$ and petiole girth) were recorded at three-month interval, whereas quality parameters (chlorophyll content, vase life and colour intensity) were taken at the harvesting stage. Total chlorophyll analysis was done with acetone method and then estimated by spectro-photometric observation (Sadasivam and Manicham, 1992). The colour intensity was recorded with the help of RHS colour chart. Vase life was recorded till the leaves began to show yellowing or atleast 5% or more of the leaves were desiccated. The data of two years were analyzed statistically at 5% level of significance with the help of OPSTAT and proper standard error (SEm±) method as suggested by Panse and Sukhamte (1989).

3. Results and Discussion

3.1. Vegetative growth

Presented data (Table 1) and photographs (Figure 1) show that the vegetative growth was influenced significantly by the colour of shade nets.

3.1.1. Plant height

The plant height increased under all the shade nets as compared to the plants treated without any shade net. Among the three shade nets, maximum plant height (109.6 cm) was observed under the green shade net, which is significantly higher than the plants grown under white and red shade nets. The minimum plant height (37.83 cm) was found in control (without shade net). This better performance in plant height under green shade net may be because of the low light intensity than the red & white shade net, which influenced the auxin transport and apical dominance (Zervoudakis et al., 2012 and Wang et al., 2009). A similar type of result was observed by Stamps and Chandler (2008) in *Aspidistra elatior* under black shade net. Nesi et al. (2013) also found highest plant height in *Hydrangea macrophylla* var. Dienemann and Tricolor under black shade net.

3.1.2. Plant spread

The plant spread was maximum (70.67 cm) under the green shade net and other shade nets also gave better performance than the control. The minimum plant spread (37.00 cm) was recorded with the plants raised without any shade net

Table 1: Effect of coloured shade nets on vegetative growth of *Asparagus plumosus* (pooled data)

Treatments	Plant height (cm)	Plant spread (cm)	Leaf length (cm)	Leaf breadth (cm)	Petiole girth (cm)
T_1	66.50	59.34	27.00	11.67	0.70
T_2	109.6	70.67	33.35	22.00	0.80
T_3	65.00	55.00	27.15	16.00	0.62
T_4	37.83	37.00	18.00	14.00	0.57
SEm±	1.30	1.62	1.09	0.55	0.03
CD (p=0.05)	4.06	5.04	3.39	1.69	0.09

T_1: White coloured shade nets (50%), T_2 : Green coloured shade net (50%), T_3: Red coloured shade net (50%) and T_4: Control (without shade net)

(control). This increase in plant spread under green shade net could be the outcome of better microclimatic conditions regarding light intensity, temperature, humidity and wind speed compared to the other shade nets (Medany et al., 2009). Khyber et al., (2019) also found maximum plant spread in *Nephrolepis cordifolia* under the green shade net.

3.1.3. Leaf length

Regarding the leaf length, the highest data (33.35 cm) was recorded in the green shade net. The plants grown under red and white shade nets were comparatively similar to each other in respect of leaf length. The lowest leaf length (18.00) was found in control (without shade net). The reduction of the net photosynthetic activity in the plants grown under red and white shade net because of more reflection and smaller PAR (Photosynthetically Active Radiation) could be the reason for lower leaf length than the green shade net (Middleton and Mc. Waters, 2002). Similar findings were reported by Khyber et al. (2019) in *Nephrolepis cordifolia* under the black colour shade net.

Figure 1a: Growth performance under white coloured shade net (50%)

Figure 1b: Growth performance under green coloured shade net (50%)

Figure 1: Continue...

Figure 1c: Growth performance under red coloured shade net (50%)

Figure 1d: Growth performance without shade net (Control)

Figure 1: growth performances of cut foliage plant (*Asparagus plumosus*) under coloured shade nets

3.1.4. Leaf breadth

Leaf breadth gave better response and recorded the widest leaf (22.00 cm) under the green shade net, whereas the least wide leaf (14.00 cm) was observed under the white colour shade net. Retamales *et al*. (2008) obtained similar results regarding leaf width in blueberry under black shade net.

3.1.5. Petiole girth

In the case of petiole girth, the highest result was obtained in green shade net (0.80 cm) followed by white coloured shade net (0.70). The petiole girth was found lowest (0.57) in control. Strong and sturdy petiole is necessary for cut foliages. Anonymous (2016b) reported better petiole girth in Asparagus under black and green shade net than the red shade net.

3.2. Leaf production

Results presented in Table 2 also depict significantly better leaf production with different coloured shade nets.

Table 2: Effect of coloured shade nets on leaf production of *Asparagus plumosus* (pooled data)

Treatments	No. of leaves plant^{-1} (nos.)	Leaf longevity (days)	Leaf production interval (days)
T_1	63.00	11.34	143.00
T_2	127.83	14.67	117.84
T_3	59.00	12.67	152.00
T_4	36.67	9.50	170.84
SEm±	1.69	0.34	1.93
CD (p=0.05)	5.25	1.06	6.03

T_1: White coloured shade nets (50%), T_2: Green coloured shade net (50%), T_3: Red coloured shade net (50%) and T_4: Control (without shade net)

3.2.1. Number of leaves plant^{-1}

The most number of leaves plant^{-1} (127.83) was found under green shade net and the least number of leaves plant^{-1} (36.67) was recorded in the plants grown without any shade net (control). The leaf production increased 3.5 times under the green shade net than that of open condition. The increase in number of leaf production may be attributed to better light use efficiency and photosynthetic rate under green shade net (Andhale et al., 2014). This result is in agreement with the findings of Meena et al. (2014) and Khyber et al. (2019).

3.2.2. Leaf longevity

Plants grown under green shade net were shown the highest leaf longevity (14.67 days) followed by red shade net (12.67 days). Lowest leaf longevity (9.50 days) was observed in the plants kept without shade net (control). The green shade net may be helps to develop higher epicuticular wax content in leaves than red and white shade net, which prevents transpiration and influence higher leaf longevity as well as longer vase life.

3.2.3. Leaf production interval

In case of the leaf production interval, plants raised under green shade net produced leaves more frequently (117.84 days) whereas the interval was recorded highest (170.84) in control. In the green shade net, less leaf production interval resulted in more number of leaf production.

3.3. Quality parameters

Significant differences were found (Table 3) regarding quality parameters among different coloured shade net treatments.

Table 3: Effect of coloured shade nets on quality parameters of *Asparagus plumosus* (pooled data)

Treatments	Chlorophyll Content (mg g^{-1})	Colour intensity (RHS colour chart)	Vase life (day)
T_1	0.59	Dark green (RHS-137A)	6.50
T_2	1.21	Dark green (RHS-136A)	7.84
T_3	0.86	Green (RHS-137C)	6.50
T_4	0.40	Green (RHS-137C)	4.17
SEm±	0.02	-	0.29
CD (p=0.05)	0.05	-	0.93

T_1: White coloured shade nets (50%), T_2: Green coloured shade net (50%), T_3: Red coloured shade net (50%) and T_4: Control (without shade net)

3.3.1. Chlorophyll content and colour intensity

Regarding chlorophyll content in the leaf, plants grown under the green shade net had the maximum chlorophyll content (1.21 mg g^{-1}) followed by red shade net (0.86 mg g^{-1}). The minimum chlorophyll content (0.40 mg g^{-1}) was recorded in control (without shade net). Stamps and Chandler (2008) observed maximum chlorophyll content in *Pittosporum tobira* under black-coloured nets. The colour intensity of the leaf was observed using RHS (Royal Horticultural Society) colour chart. The leaves of *A. plumosus* raised under green shade net recorded the highest colour intensity among the treatments and belonged to the Dark Green (RHS-136A) group, whereas lowest colour intensity (Green: RHS-137C) is observed in red colour shade net and control. The higher PAR shading under green shade net compared to the other treatments could be the reason for dark green colour and more chlorophyll content (Ilic et al., 2015).

3.3.2. Vase life

The longest vase life (7.84 days) was found under the green shade net kept in tap water at ambient conditions. No significant difference was recorded between the red and white shade net treatment regarding the vase life. The shortest vase

life (4.17 days) was observed in the plants grown without any shade net (control). Gaurav et al. (2016) also found the better result regarding the vase life in *Cordyline terminalis* under the black and green shade net than red and white shade net.

4. Conclusion

The plants grown under the green colour shade net were found to be superior compared to the red and white colour shade net regarding all the physiological and quality parameters. Hence, the green colour shade net can be recommended for the commercial cultivation of *Asparagus plumosus* to get better quality production and comparatively higher price in the market.

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